EXHIBIT 21

Econometrics

Legal, Practical, and Technical Issues

Second Edition

SECTION OF ANTITRUST LAW
Promoting Competition Protecting Consumers

AMERICAN BAR ASSOCIATION
Defending Liberty Pursuing Justice

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FOREWORD

The Section of Antitrust Law is pleased to publish Econometrics: Legal, Practical, and Technical Issues (Second Edition). Econometrics plays a central role in modern antitrust litigation and merger analysis, and economic experts are regularly the star witnesses in court and before the enforcement agencies. With the advent of increasingly sophisticated econometric techniques, it is more important than ever for practicing antitrust lawyers to have a complete and current understanding of these techniques and how to use them. This volume explains in plain language the technical elements of econometric analyses and the situations in which they can be properly deployed. Because nine years have passed since the first edition, this book is much more than just an update. It has been substantially rewritten, reorganized and expanded to reflect the increasingly important and complex roles that econometrics and economics play in antitrust analysis and litigation.

The Antitrust Section is grateful to the many economists and lawyers who worked on this book. The Section is especially grateful for the exceptional and tireless work of the book's editor, Lawrence Wu, who organized and supervised a talented cadre of economists (with the help of some lawyers) to produce a book that is both technically sound and accessible to non-economists. He was assisted by Charles Biggio, who is the co-editor of this volume. The Section also thanks the individuals who devoted so much time to researching, drafting and revising the substantial new content in this book. They, as well as many others who made significant contributions, are credited by name in the Preface.

February 2014

Christopher B. Hockett
Chair, Section of Antitrust Law
American Bar Association
2013-2014

from the effect of the other on the dependent variable. The model cannot be estimated.

Multicollinearity occurs when two or more explanatory variables are highly but not perfectly correlated. A model exhibiting multicollinearity can be estimated, unlike a perfectly collinear model, but OLS coefficient estimates may be difficult to interpret. First, the OLS-estimated coefficient of one variable, say β_1, is interpreted to measure the change in Y when X_1 changes, assuming all the other independent variables are held constant. However, if two variables X_1 and X_2 are highly correlated, X_2 is likely to change predictably whenever X_1 changes. Second, as the correlation between two or more explanatory variables increases, so do the standard errors of OLS-estimated regression coefficients. Large standard errors reduce the precision of OLS coefficient estimates and make it more difficult for an expert to reject the null hypothesis of a hypothesis test. Under these circumstances, failure to find a relationship between an explanatory variable and the dependent variable does not necessarily mean that none exists. It may be impossible for an expert to determine whether a relationship exists given the data available.

To determine if multicollinearity exists, an expert may look at the standard errors of OLS coefficient estimates. If they are high, the expert can re-estimate the model excluding one or more of the explanatory variables suspected of causing multicollinearity. Lower standard errors on the remaining variables are suggestive of multicollinearity in the original model. The dropped variable(s) may cause the re-estimated model to suffer from omitted-variable bias.

Normal Distribution: A probability distribution that OLS parameter estimates are assumed to follow. If a variable X is normally distributed, its probability distribution exhibits a bell-shaped pattern as shown in Figure 5.

Null Hypothesis: The assumption tested in a hypothesis test, denoted as H_0.

Omitted-Variable Bias: An omitted variable is a relevant explanatory variable that is excluded from a regression model, leading to a misspecification of the relationship between the dependent variable Y and the included independent variables X. When data on an

omitted variable are available, the problem is readily corrected by adding the omitted variable to the model.

When data on the omitted variable are not available, the problem is more serious. The omitted variable is then automatically included in the error term of the model. If one or more included explanatory variables are correlated with the omitted variable, as is often the case, those variables are correlated with the error term. The included variables may be credited with an effect actually attributable to the omitted variable; this over- or underestimation of OLS regression coefficients is known as omitted-variable bias. The estimated coefficients are both biased and inconsistent (in large samples).

As in the car sales-GDP-gas price model presented above, suppose annual U.S. car sales depend on both GDP and the nationwide average retail gas price:

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i \,,$$

where Y is car sales, X_1 is GDP and X_2 is gas price. If gas price data are not available, X_2 is omitted from the regression and the model becomes

$$Y_i = \alpha + \beta_1^* X_{1i} + \varepsilon_i^* \,.$$

To the extent that GDP and gas price are correlated, the coefficient on GDP in the latter equation, β_1^*, picks up some of the effect of the omitted gas price variable on car sales and thus is biased. Generally the only case in which omitted-variable bias disappears is when an omitted variable is uncorrelated with *all* included explanatory variables, an unlikely scenario.

There are several ways to address omitted-variable bias when data on the omitted variable(s) are not available. One possible method is to obtain data on a proxy variable related to the omitted variable, if such a proxy variable exists. For example, IQ is often used as a proxy for unobservable "ability" in models estimating wages as a function of education, experience and ability. If the omitted variable can be assumed not to change over time, fixed effects or differencing techniques can be used to estimate the model (see, e.g., Wooldridge pp. 438-450). Instrumental variables and two-stage least squares estimation techniques can also resolve omitted variables problems and yield consistent parameter estimates. If none of these corrections are applicable, an expert should at the very least be prepared to discuss potential omitted variables and the likely direction and size of any omitted-variable bias on the variables included in the model.

It may be possible for an expert to account for omitted-variable bias qualitatively if the expert has knowledge about the relationship between the omitted variable and the explanatory variable(s) of interest. For example, suppose in a sex discrimination pay case that women are on average more skilled than men. However, the expert cannot obtain quantifiable data reflecting necessary job skills. The expert's regression of the wage rate on years of experience and a gender indicator variable suggests that men are paid more than women with the same experience. Since differences in skill level have not been accounted for, the expert may reasonably conclude that the estimated wage difference is a conservative estimate of the true difference.[44]

Both the direction and the size of omitted-variable bias are important. When there are multiple explanatory variables included in a model, it is not always straightforward to determine the direction of omitted-variable bias on a particular included variable. Even if the omitted variable(s) are only correlated with one included explanatory variable, generally the coefficients on all included explanatory variables are biased.[45]

Ordinary Least Squares (OLS) Regression: OLS is most basic method of regression analysis and defines a linear relationship between a dependent and one or more independent variables. An OLS model specifying a dependent variable as a linear function of k independent variables is written as $Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_k X_{ki} + \varepsilon_i$.

Outlier: An outlier is a data point that lies far from the regression line that fits all other points in a data set. OLS regression can be sensitive to extreme data points. Consider Figures 6 and 7:

44. Daniel L. Rubinfeld, *Reference Guide on Multiple Regression*, in FEDERAL JUDICIAL CENTER, REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 189 (2d ed. 2000).

45. For a derivation of the size of omitted-variable bias, see PINDYCK & RUBINFELD, *supra* note 27, at 184-186.

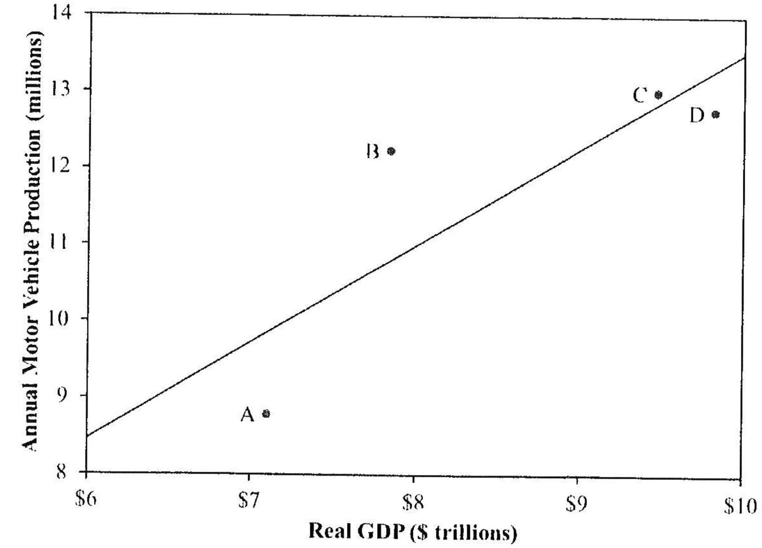

Figure 6. U.S. Motor Vehicle Production and GDP

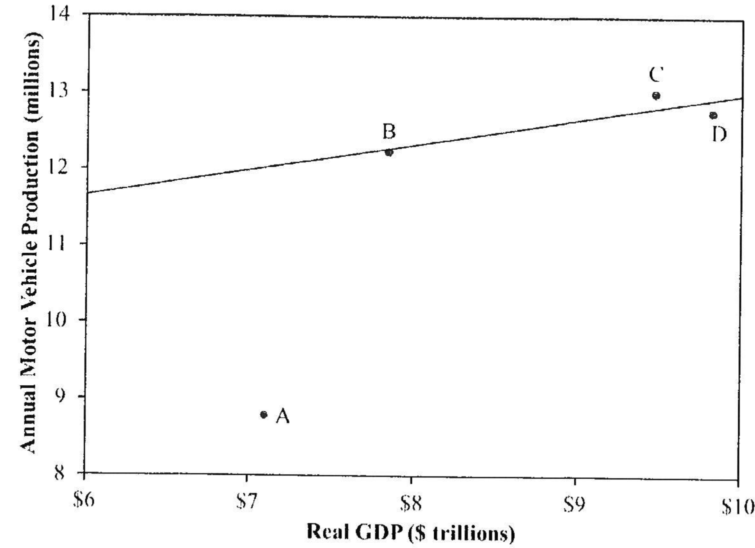

Figure 7. U.S. Motor Vehicle Production and GDP

The OLS regression line in Figure 6 describes the best-fitting relationship between Points A, B, C and D. Figure 7 shows the best-fitting OLS regression line describing the relationship between Points B, C and D only. The flatter regression line in Figure 7